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AQA

Surname _____

Other Names _____

Centre Number_____

Candidate Number_____

Candidate Signature _____
I declare this is my own work.

Level 3 Certificate
MATHEMATICAL STUDIES

Paper 2C   Graphical Techniques

1350/2C

Time allowed: 1 hour 30 minutes

For this paper you must have:
- **a clean copy of the Preliminary Material and the Formulae Sheet (enclosed)**
- **a scientific calculator or a graphics calculator**
- **a ruler.**

At the top of the page, write your surname and other names, your centre number, your candidate number and add your signature.

[Turn over]

INSTRUCTIONS

- **Use black ink or black ball-point pen. Pencil should only be used for drawing.**

- **Answer ALL questions.**

- **You must answer the questions in the spaces provided. Do not write on blank pages.**

- **If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).**

- **Show all necessary working; otherwise, marks for method may be lost.**

- **Do all rough work in this book. Cross through any work you do not want to be marked.**

- **The FINAL answer to questions should be given to an appropriate degree of accuracy.**

- **You may NOT refer to the copy of the Preliminary Material that was available prior to this examination. A clean copy is enclosed for your use.**

INFORMATION

- **The marks for questions are shown in brackets.**

- **The maximum mark for this paper is 60.**

- **You may ask for more answer paper or graph paper, which must be tagged securely to this answer booklet.**

DO NOT TURN OVER UNTIL TOLD TO DO SO

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Answer ALL questions in the spaces provided.

1   The plans for a new housing estate include 80 properties of different types.

The table shows the planned number of each type of property.

TYPE OF PROPERTY	PLANNED NUMBER OF THIS TYPE
1-bedroom flat	10
2-bedroom flat	15
2-bedroom house	25
3-bedroom house	20
4-bedroom house	5
5-bedroom house	5

1 (a)   Work out the ratio of houses to flats.

Circle your answer. [1 mark]

5 : 11   11 : 5

5 : 16   16 : 11

[Turn over]

The local council must approve the plans for the housing estate.

To be approved, the plans must meet some minimum requirements.

1 (b) Here are the minimum requirements for the number of cycle parking spaces.

- 1 space PER BEDROOM up to and including 3-bedroom properties
- 3 spaces for 4-bedroom properties
- 4 spaces for 5-bedroom properties
- PLUS some visitor cycle parking

The plans for the housing estate include 185 cycle parking spaces.

Do the plans meet the minimum requirements?

You MUST show your working. [3 marks]

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07

1 (c)   The developers building the housing estate want to change their plans.

They make more profit on 2-bedroom houses than on 2-bedroom flats.

To approve the plans, the local council insists that

- there must still be 80 properties
- at least 23% of the properties are classified as 'affordable housing'.

The table shows which properties are classified as 'affordable housing'.

TYPE OF PROPERTY	AFFORDABLE HOUSING	PLANNED NUMBER OF THIS TYPE
1-bedroom flat	✓	10
2-bedroom flat	✓	
2-bedroom house	✗	
3-bedroom house	✗	20
4-bedroom house	✗	5
5-bedroom house	✗	5

Complete the table to show the number of 2-bedroom flats and 2-bedroom houses that would be approved and make the greatest profit. [3 marks]

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2 **Use ELECTRICITY GENERATION from the Preliminary Material.**

2 (a) **The bar chart shows how each of the four nations of the United Kingdom generated electricity in 2019**
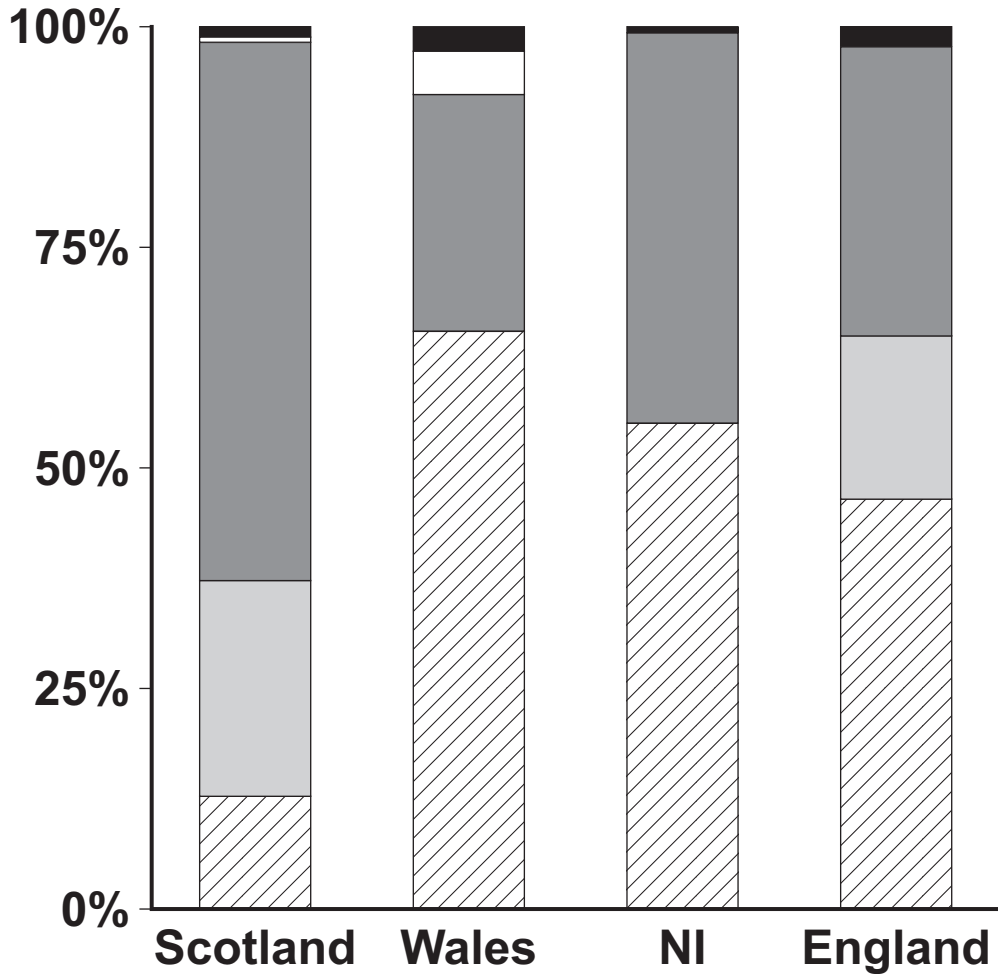
KEY

☐ **Pumped storage**   ▨ **Nuclear**

▨ **Renewables**   ▨ **Fossil fuels**

Suggest TWO improvements that could be made to the bar chart. [2 marks]

Improvement 1

_____

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Improvement 2

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2 (b)   Two newspapers reported on electricity generation in England in 2019

Electricity generated by renewables reached more than 70% of that generated from fossil fuels.

'Morning Record'

The ratio of wind to other renewables is about 13 : 17

'Daily Bulletin Review'

Using TABLE 1 in the Preliminary Material, comment on the validity of each newspaper's claim.

You MUST show your working. [5 marks]

Morning Record

_____

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Daily Bulletin Review

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[Turn over]

2 (c) In 2019, Northern Ireland generated 4189 GWh of electricity by renewables.

The average cost of electricity was 14.4p per kWh

1 GWh = 1 000 000 kWh

Anna says,

"In 2019, Northern Ireland generated electricity by renewables worth over 600 million pounds."

Is she correct?

You MUST show your working. [3 marks]

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2 (d)   **In 2019, Wales generated 7700 GWh of electricity by renewables.**

Work out the total amount of electricity generated in Wales from all fuels. [2 marks]

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Answer _____ GWh

[Turn over]

2 (e) Bobby wants to work out the mean percentage of electricity generated by renewables in the UK.

Here is his calculation, which uses the values from CHART 1 in the Preliminary Material.

> **61.1 + 44.6 + 33.0 + 26.9 = 165.6**
>
> **165.6 ÷ 4 = 41.4**
>
> **So 41.4% of energy generated in the UK in 2019 was by renewables.**

The article states that 37.1% of energy generated in the UK in 2019 was by renewables.

Critically analyse Bobby's method, explaining why his percentage does not agree with the article.

You do NOT need to carry out any calculations. **[1 mark]**

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[Turn over]

3   A computer game has five levels.

The score, S, a player achieves on the game is dependent on two variables,

the number of enemies defeated, N,

and

the level on which the game is played, L.

The score is calculated using the formula
$S = N \times 10^{\,L-1}$

3 (a)   The maximum possible score on a level is achieved by defeating all of the enemies on that level.

The number of enemies increases by 50 each time the player moves up a level.

Complete the table. **[3 marks]**

Level	Number of enemies	Maximum possible score
1	100	100
2	150	1500
3	200	
4		
5		

3 (b) In a tournament, players are awarded an adjusted score, A, using the formula

$A = \log_{10}(S)$

Two tournament players have their scores recorded.

The table shows some of the adjusted scores for the two players.

	PLAYER ONE		PLAYER TWO	
LEVEL	S	A	S	A
1	85	1.93	15	1.18
2	1250	3.10	300	2.48
3	16 300	4.21	5800	
4	199 000	5.30	115 000	
5	2 510 000	6.40	2 240 000	

3 (b) (i) Complete the table, giving each value to two decimal places. **[2 marks]**

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[Turn over]

The graph shows the adjusted scores for Player One.
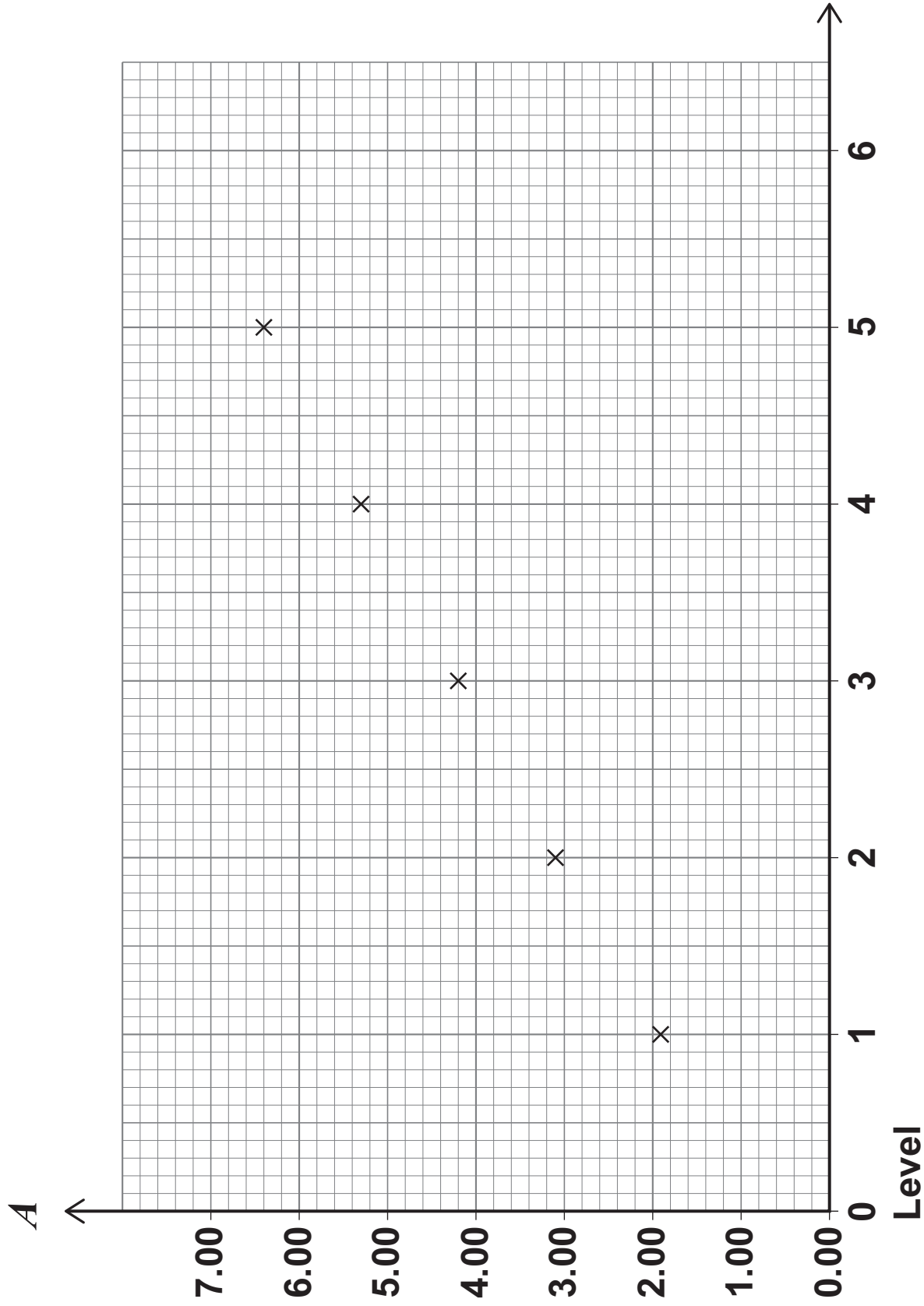
3 (b) (ii) Plot the adjusted scores for Player Two on the same graph.
[1 mark]

3 (b) (iii) A sixth level is added to the game.

Player Two makes the following prediction.

"I predict I will get a higher score than Player One on level 6"

Use the graph to comment on Player Two's prediction. [2 marks]

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4   Nikita conducts an experiment to measure how the temperature of drinks can be lowered by adding ice to a cooler box.

She repeats the experiment for different masses of ice.

The drinks are all initially at 22°C and she records the final temperature of the drinks when all of the ice has melted.

MASS OF ICE ADDED (KG)	0	0.5	1	1.5	2
FINAL TEMPERATURE OF THE DRINKS (°C)	22	15.5	10.5	6	2.5

She enters these readings into a computer that produces a graph modelling the final temperature, T °C, of the drinks for the mass of ice, m kg, added to the cooler box.
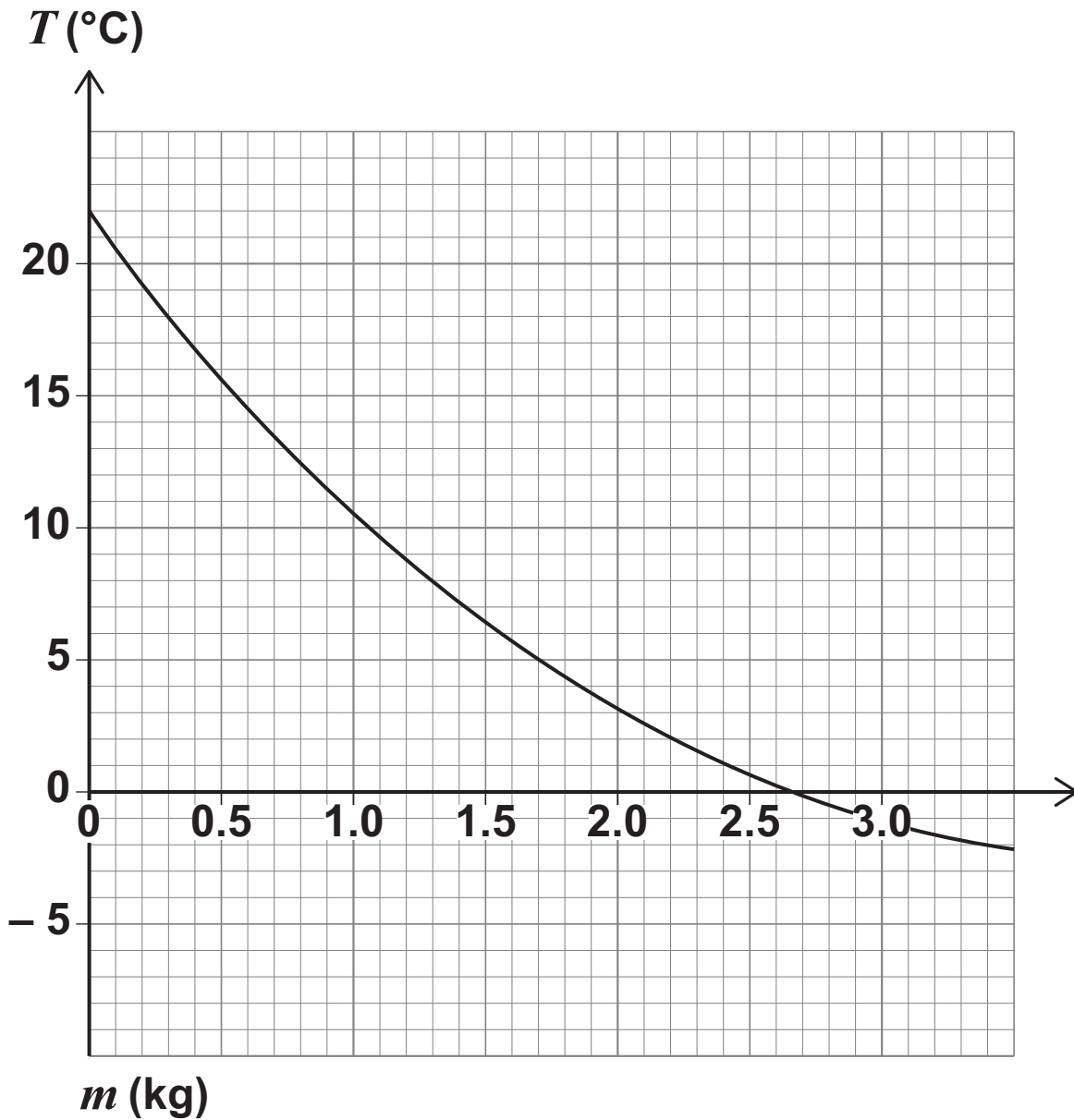
4 (a)   An ideal temperature for cold drinks is 4 °C

Use the model to estimate the minimum mass of ice required to cool them to 4 °C **[2 marks]**

Answer _____ kg

[Turn over]

4 (b)   Nikita states that increasing the mass of ice from 0.2 kg to 0.3 kg has more of an effect than increasing the mass of ice from 2.0 kg to 2.1 kg

Is Nikita correct?

Use the graph to explain your answer.

You do **NOT** have to work out the rate of change. [1 mark]

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4 (c)   The model can also be represented by the equation

$$T = 1.86m^2 + Bm + C$$

Using the measurements from Nikita's experiment, work out the values of B and C. [4 marks]

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B = _____   *C* = _____

4 (d)   Describe ONE limitation of this model.

You may refer to the graph or the equation.
[1 mark]

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[Turn over]

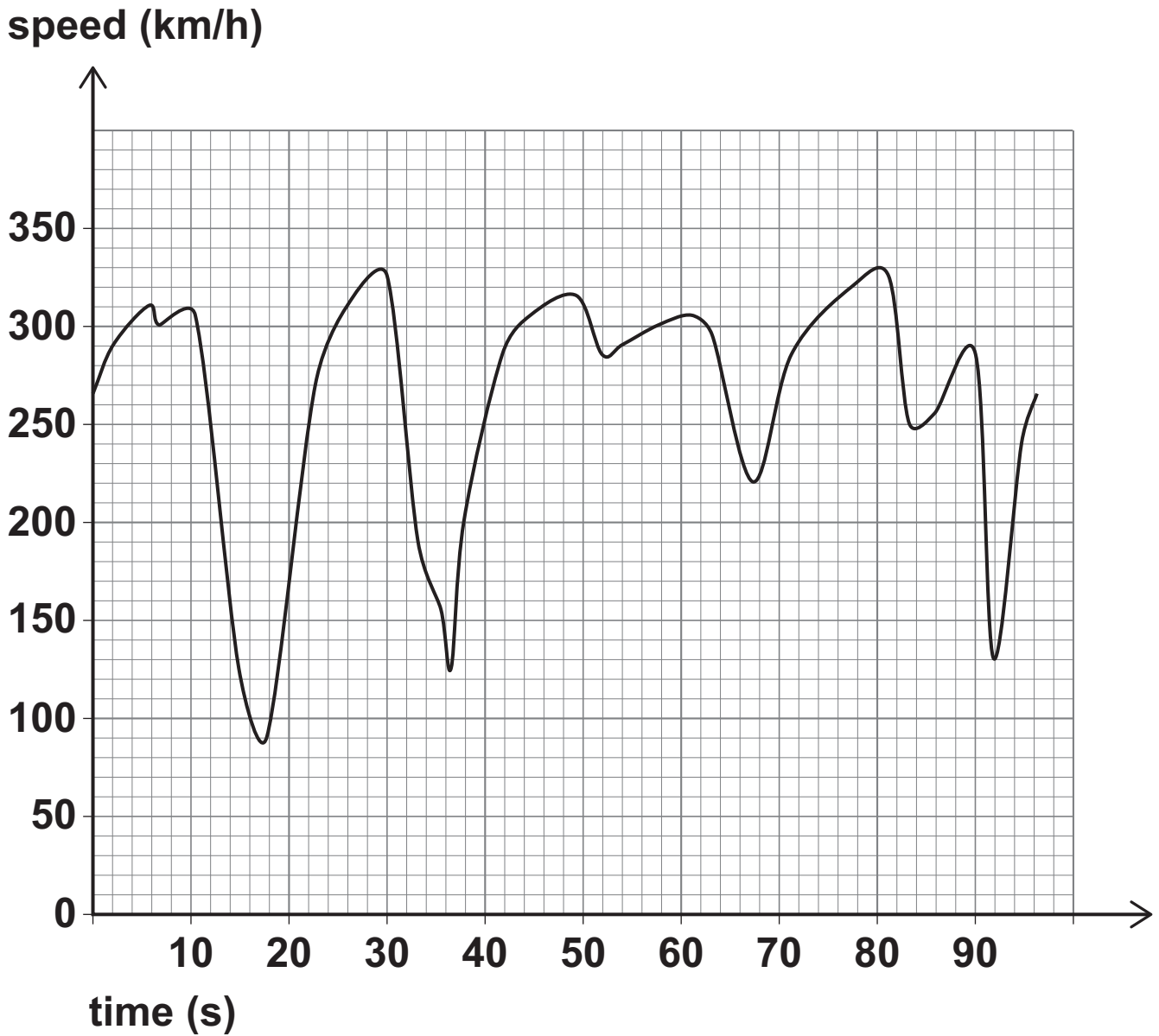**5**   A Formula 1 driver is testing a car on a track.

5 (a) The time it would take to complete one lap driving at the UK national speed limit of 112 km/h is 2.12 times greater than the time it took the driver to complete his fastest lap.

Work out the average speed for the fastest lap.
[2 marks]

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Answer _____ km/h

5 (b) The graph below shows the speed of the car during the fastest lap.
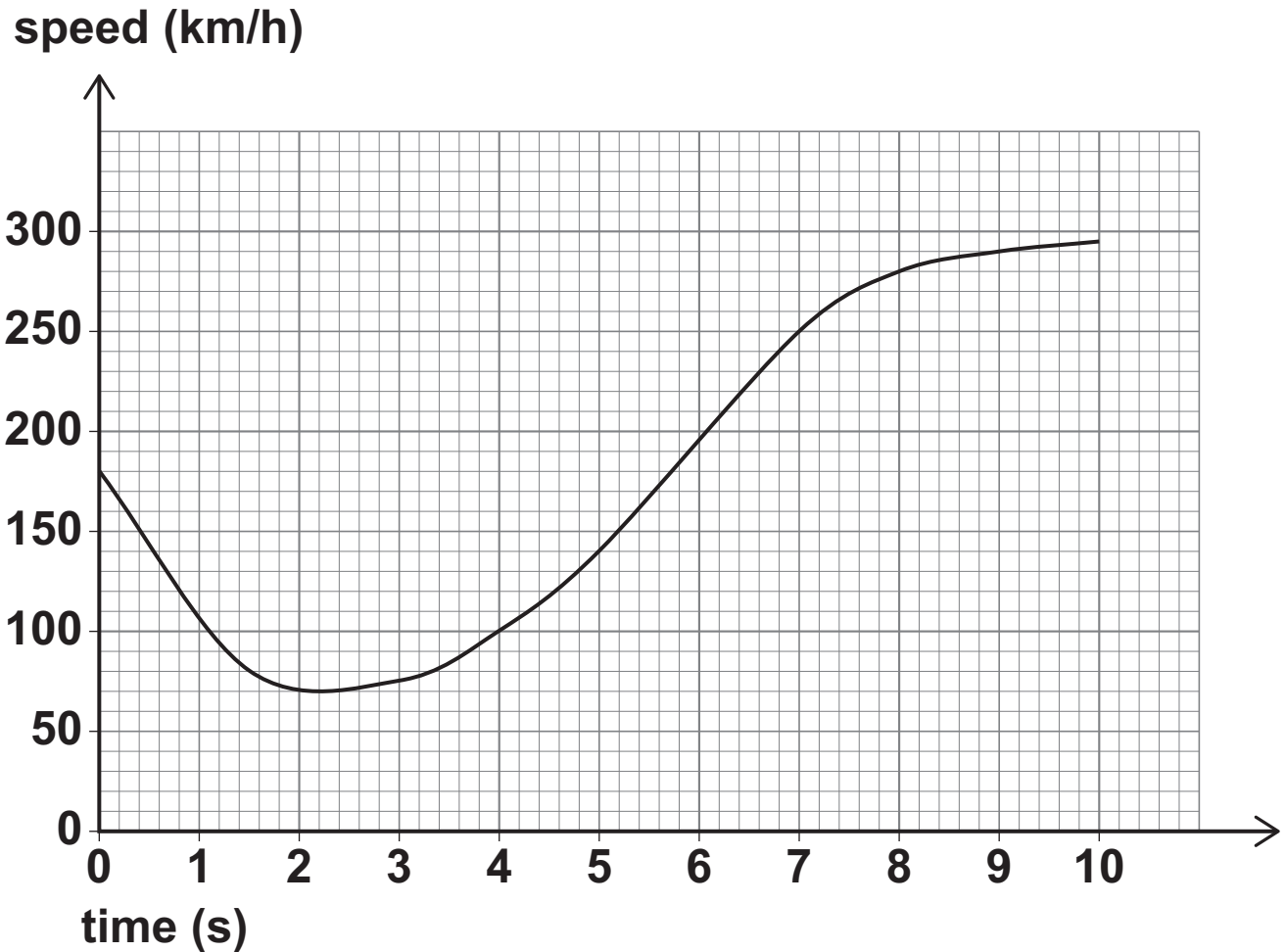
speed (km/h)

time (s)

[Turn over]

Using the graph and your answer to QUESTION 5(a),

work out the distance in km travelled by the car on the fastest lap. [3 marks]

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Answer _____ km

5 (c) **The graph below shows the speed of the car in km/h over a 10-second period on another lap, measured from entering one of the corners.**

speed (km/h)

time (s)

[Turn over]

Estimate the acceleration of the car 8 seconds after entering the corner.

Give your answer in ms⁻² [5 marks]

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Answer _____ ms⁻²

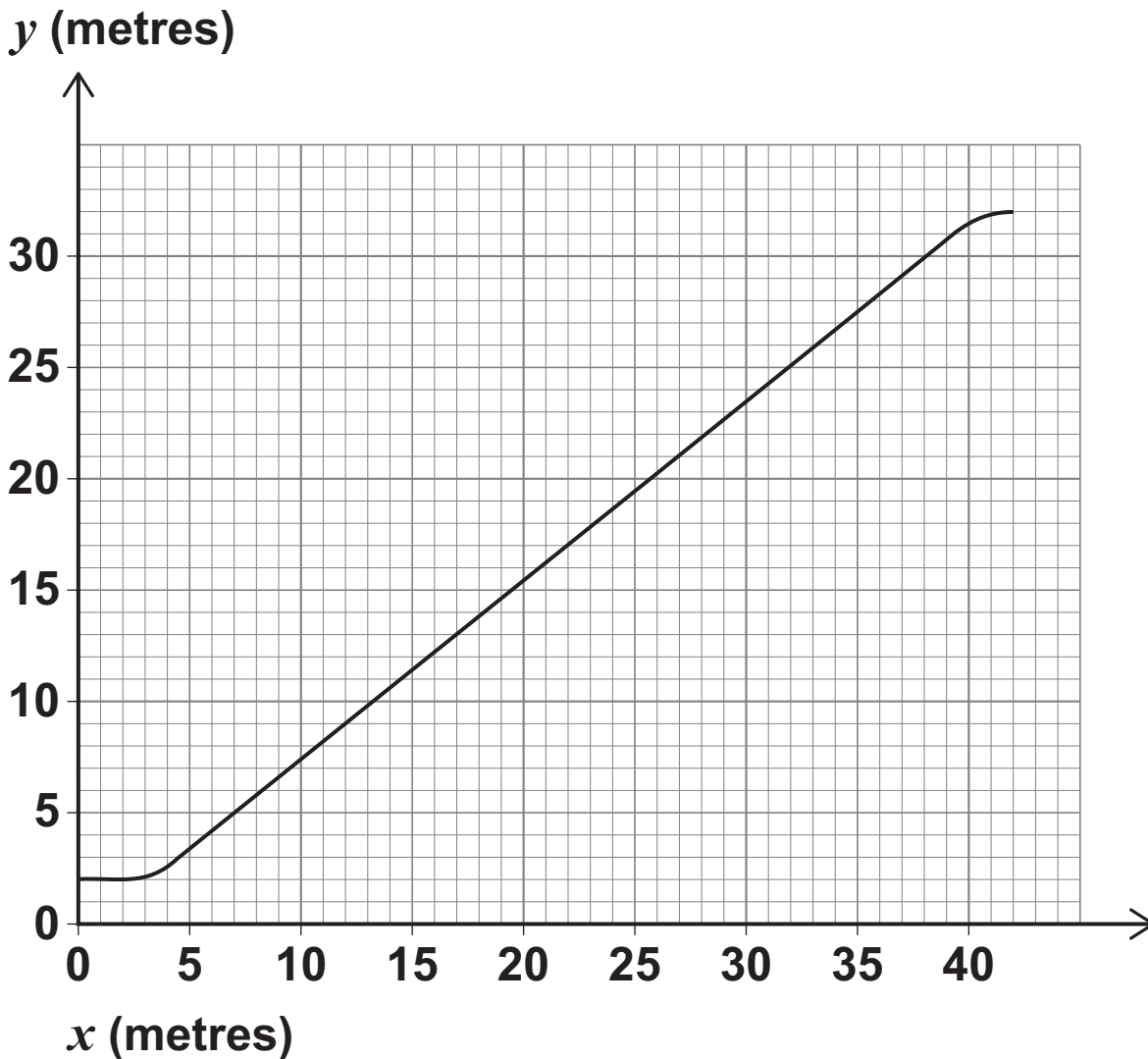**BLANK PAGE**

[Turn over]

6 A rollercoaster is constructed by joining sections of track.

Equations are used to design each section of track.

6 (a) The side elevation of the first section of the rollercoaster is shown on the graph.

x is the horizontal distance from the start of the section

y is the height of the track above ground level

y (metres)

x (metres)

The graph is linear for $5 \leqslant x \leqslant 38$

Work out the equation of the line for
$5 \leqslant x \leqslant 38$

Give your answer in the form $y = mx + c$
where m and c are constants. **[4 marks]**

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Answer _____

[Turn over]

6 (b) **The next section of rollercoaster track is a downhill section.**

The side elevation of this downhill section is shown on the graph below.
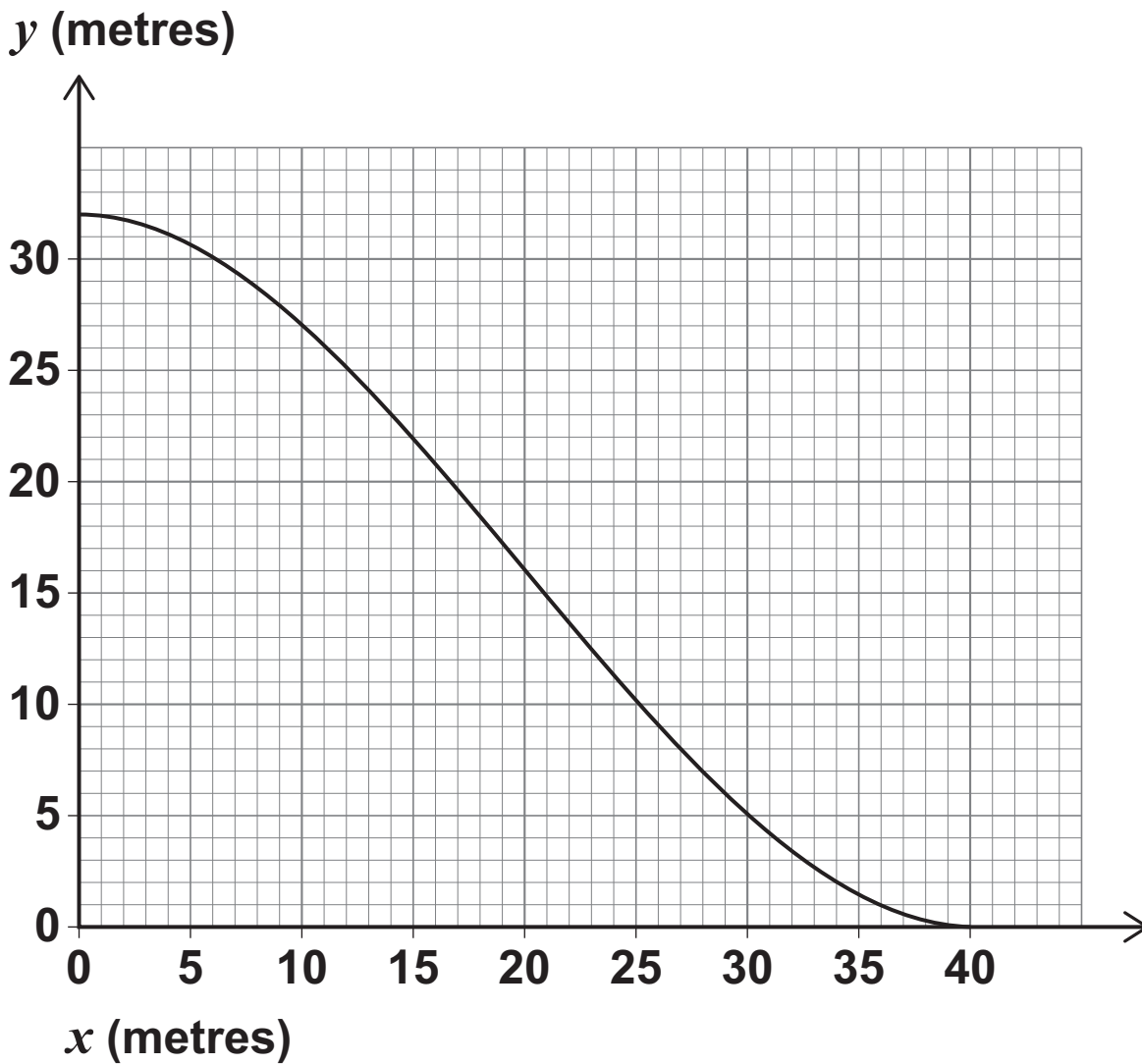
Which equation represents this downhill section of track?

Circle your answer. [1 mark]

$y = 0.001x^3 - 0.06x^2 + 32$

$y = 0.001x^3 - 0.06x^2 - 32$

$y = -0.001x^3 - 0.06x^2 + 32$
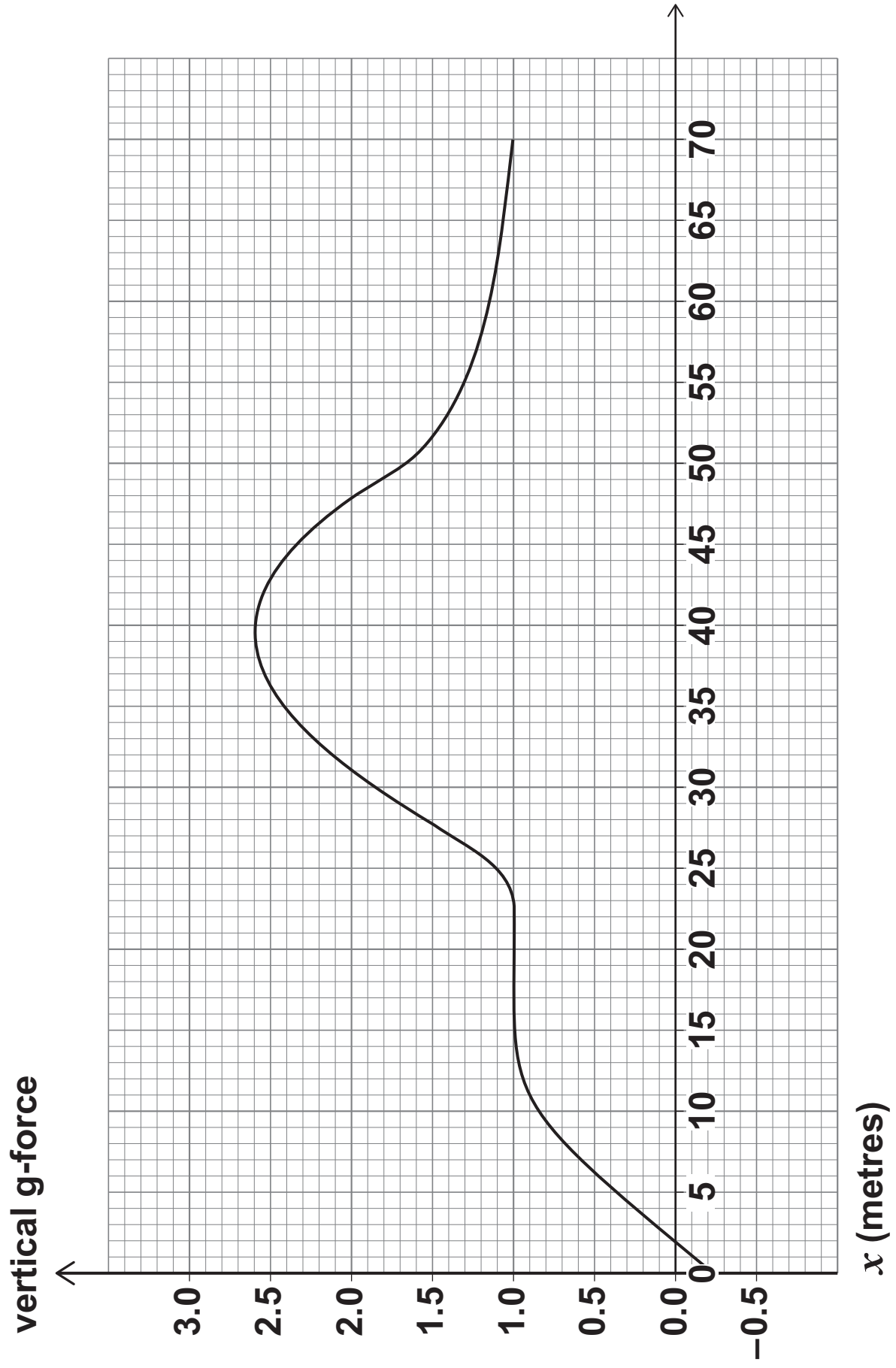
$y = -0.001x^3 - 0.06x^2 - 32$

[Turn over]

6 (c) Rollercoaster riders experience vertical g-force.

When vertical g-force is greater than 1, riders feel heavier than normal.

The graph below shows the vertical g-force that rollercoaster riders experience over a 70m section of the track, where x metres is the horizontal distance from the start of the section.

vertical g-force

x (metres)

Estimate the time in seconds the rider will feel heavier than normal during this 70 m section.

Assume that the rollercoaster travels at a constant horizontal speed of $12 \, ms^{-1}$ [3 marks]

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Answer _____ s   8

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[Turn over]

7   The intensity of direct sunlight can be measured in lumens.

Light intensity decreases in the hour before sunset.

At sunset there is zero direct sunlight.

The equation to model the intensity of direct sunlight, L lumens, at time t minutes before sunset is

$$L = L_o(1 - e^{-kt}) \qquad \text{where } 0 \leqslant t < 60$$

L_o is the intensity of direct sunlight one hour before sunset.

The constant k takes into consideration the atmospheric conditions, location and time of year.

On one particular day,

- the sun sets at 6 pm
- the light intensity 10 minutes before sunset is HALF the light intensity at 5 pm
- the light intensity 30 minutes before sunset is 85 000 lumens.

Calculate the light intensity predicted by the model 5 minutes before sunset. **[6 marks]**

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Answer _____ **lumens**

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END OF QUESTIONS

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